Toxic emissions and devalued CO2-neutrality

Stem wood burning violates sustainable development

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Toxic emissions and devalued CO_2- neutrality: Stem wood burning violates sustainable development

by

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Abstract

The paper proposes the thesis that a counterproductive effect of dioxin formation in the cooling phase of wood burning appliances has been registered corresponding to the de-novo-synthesis which through the years has been fully accepted as a mechanism of dioxin formation in municipal solid waste incinerators (MSWI). Therefore, stronger regulations are recommended for wood burning appliances comparable to those that led to EU norms for MSWIs.

Both researchers, regulators and the public are, however, preoccupied by notions of oven design and operation parameters, assuming that dioxin behaves on line with other toxic pollutants from incomplete combustion. Evidence is given that this is not the case. Based upon both earlier and recent research of the author as well as new findings, specificities of the dioxin from combustion problem are reconstructed.

The favourable treatment of wood stoves in the newly prioritised climate and energy policy nexus is analysed critically arguing for a real-historical devaluation of an assumption of CO2-neutrality in case of burning wood. Alternative practices as storing C in high quality wood products and/or leaving dead wood in the forest are mentioned.

As a normative frame of reference for evaluating actual toxics reduction policies the Stockholm Convention on POPs is presented. Denmarks function as lead country for dioxin in the context of the OSPAR Convention is mentioned. Climate policy is seen in relation to goals of CO2-reduction. Societal-historical problems of lacking courage in dioxin policies are dealt with, contrasted with more autonomous research initiatives from around the world. Sustainability is related to these issues by making different understandings of the 1987 report of the World Commission on Environment and Development operational and trying to contribute to sustainable development at world-system scale. Some mental barriers against that are, hopefully, being lifted.

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Academic disciplines involved:

Ecological economics, political ecology, world-system analysis

Keywords:

Stockholm Convention, POPs, dioxin formation, dioxin destruction, waste incinerators, wood stoves, CO2 balances, greenhouse effect, irreversible time, end-of-pipe regulation, substitution, dioxin health effects

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Introduction

In order to use the concept of sustainable development without reducing it unduly, a threefold approach to its dimensions is chosen, as proposed within the UNESCO/Most project on 'Sustainability and the Social sciences' (Becker and Jahn 1999). This refers to overlapping normative, analytical and political dimensions.

By projecting the three classic 'definitions' of sustainable development from the 1987 Report of the World Commission on Environment and Development (WCED 1987) on these dimensions, the overall concept of sustainable development can be made operational in the following way:

(a) within the normative dimension we find the visionary definition regarding intergenerational justice in terms of potentials for sustenance,[1] which means that collective norms of justice have to be confronted with their gradual or transformative implementation;

(b) within the analytic dimension we find the balancing definition regarding sustainable resource use,[2] which demands process analyses within and between four basic drivers of change;

(c) within the political dimension we find in the concluding section of the WCED chapter 'Towards sustainable development' a list of 7 systemic prerequisites for the

[1] "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs "(WCED 1987, 51)

[2] "In essence, sustainable development is a process of change, in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet humans needs and aspirations" (WCED 1987, 54)

realisation of sustainable development[3] formulated as guidelines for national and international action on development. They must be compared with real developments in order sincerely to "correct departures from them"(WCED 1987, 55).

Here, the dimensions of globalisation are relevant, as e.g. listed in the 3rd edition of Peter J. Taylor's and Colin Flint's "Political Geography", its globalisation edition (R.C.-Dupont 2006c). This comparison shows, how the first wave of sustainability politics succumbed for neo-liberal globalisation in its different sectors and why a new impetus of rethinking sustainable development from the basics of societal-metabolic restructuring up into the world-systemic level is needed (R.C.-Dupont 2003).

This text deals with a normative frame of reference in relation to toxics reduction policies and asks whether these *norms* are being fully implemented (ch.1); it goes into *analytical* discussions of developments within technology assessment of central units of waste incineration as well as de-central units of home heating and asks for an evaluation of some of the inherent properties of the latter, seen on the background of a learning process achieved with the former (ch. 2 and 3) – and it asks for a *resource-specific differentiation*, when the label of CO2-neutrality is attached to devices and processes of burning all biomass (ch.4); when this hurdle is eliminated, policy approaches of regulating and/or substituting individual wood burning are contrasted as different options for *institutional change* in this policy field (ch.5); and on a still more complex *historical-societal* level it is asked, whether world political developments have inhibited a more open and cooperative ("*harmonious*") research policy regarding toxic effects of dioxin poisoning and potential protective measures against this creeping catastrophe (ch.6).

[3] The list comprises the requirement of "a political system that secures effective citizen participation in decision making, an economic system that is able to generate surpluses and technical knowledge on a self-reliant and sustainable basis, a social system that provides for solutions for the tensions arising from disharmonious development, a production system that respects the obligation to preserve the ecological basis for development, a technological system that can search continuously for new solutions, an international system that fosters sustainable patterns of trade and finance, and an administrative system that is flexible and has the capacity for self-correction" (WCED 1987, 55)

1. Implementation problems of the Stockholm-Convention on persistent organic pollutants (POPs)

The recently established Stockholm Convention on a group of chemicals identified as ‚persistent organic pollutants'[4] opens for effective control measures, which according to international law specialist and German Member of the Federal Parliament (MdB) Norman Paech could improve chances for sustainable development world-wide:

„The Stockholm Convention on persistent organic pollutants of May, 22 2001, which entered into force in 2004, intended to focus upon those public health concerns, which especially in developing countries result from exposition to these substances. This applies especially to impacts on women and thereby also future generations. The cooperation of women in developing and realising plans of implementation for the rules laid down in the Convention should also be stressed. It was e.g. agreed to interdict respectively restrict in different ways the im- and export of a number of chlorinated hydrocarbon compounds, albeit with some exceptions. Furthermore, it was stated that international goods and waste traffic with highly – e.g. by dioxins/furans - contaminated products and wastes only shall proceed if compliant with international norms and standards (Stockholm Convention 2001, Präambel, Art. 3, Abs. 1 u. 2, Art. 6, Abs. 1)" (Paech 2007).

It is well-known from developing countries that millions of persons, especially women, are immediately affected by air pollution from indoor burning devices. In principle, however, individual wood stoves in developed countries only 'control' the same kind of pollution by shifting it outwards from the polluter's own dwelling and into the nearest human or non-human neighbours' environment. What is deficient with this kind of regulation by dilution can only be learnt by high-tech analyses and by way of comparison with technically more advanced solutions as those applied in collective energy transforming or legal waste burning installations, see chapters 2 and 3. Based upon evidence presented below, one can argue for restrictions against the burning of wood in stoves of conventional type because even in optimal conditions they emit a self-generated freight of considerable toxicity, not the least of dioxins/furans, to the environment and thus to humans – either directly by contamination of fresh air or indirectly via depositions in ecosystems used e.g. for growing food.

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[4] At the Conference of Plenipotentiaries on the Stockholm Convention on Persistent Organic Pollutants, held 22 to23 May 2001 in Stockholm, Sweden, the Convention was adopted and opened for Signature. It remained open for signature at the United Nations Headquarters, Treaty Section, in New York, untill 22 May 2002.

1.1 Overriding importance given to CO2-credits

Governments, which have ratified the Stockholm Convention, report regularly on their plans of implementation. Corresponding to the role of Danish research as a 'lead country' for dioxin within the OSPAR Convention's strategy for reducing eco-toxic substances, the Danish progress report of 2006 on implementing the Stockholm Convention led to an intellectual and potentially political sensitisation, when it came to practical conclusions: *„a number of studies have demonstrated that dioxin releases from stoves and farm installations which burn straw can be considerable, and they are related to the size of the installation. … Total emissions could be reduced with a ban on burning biomass in small installations without flue gas purification …"* This analytically based statement is, however, immediately followed by a couple of intertwined political interdictions*: „… but such an initiative could have undesirable effects in the context of the goals to reduce total CO2 emissions, and it would be hard to enforce…"*[5]

Practical difficulties of stopping biomass burning in small units can only be overcome by a realistic information policy stressing the salience of innovative research results on e.g. dioxin formation and emission, see below, and by inviting to broad democratic decision making as for remedies and alternatives. Danish grass root organisations and established patient organisations e.g. of asthma and allergy patients have, thus, engaged in public campaigns informing about such risks.

The interdiction because of climate policies generates, however, a problem of lacking differentiation regarding wood and straw burning, respectively. It is no solution, but a real political problem for administrations that laws and regulations promoting the use of biomass for energy purposes have compounded all kind of biomass and given them an a-priori credit of being 'CO2-neutral'. In the case of straw firing, the argument might be correct, because it is practically feasible that next year's yield of straw binds an equal amount of CO2 as has been burnt in year zero. The same can, however, not be said a-priori about the re-binding of say 50-100 years of CO2 accumulated in stem wood being burnt within a short span of time, see the arguments presented below in chapter 4.

[5] See section 4.1.2, Annex C part III of the National Implementation Plan Stockholm Convention on Persistent Organic Pollutants, Danish Ministry of the Environment, May 2006 (Action Plan for the reduction of emissions from unintended production of dioxin, PCB and HCB)

1.2 In want of better research and control measures

Here it can be concluded, that another research policy for environment and climate protection is needed in order to (a) substitute more realistic models of CO2-balances between emission and binding connected to wood combustion and (b) unlock the stalemate which has been reached in policies of toxic emissions reduction by the interdiction on behalf of climate policy. Only then serious local health threats from dioxin emissions from wood burning in small appliances without gas cleansing will be reduced –as it is intended by the POP Convention. Civil society organisations have to take care of this task. [6]

A recent report of the Danish National Environmental Research Institute on 'Brændeovne og små kedler – partikelemission og reduktionstiltag' (Wood stoves and small boilers – particle emissions and reduction measures) [7] uses in its welfare economical analysis of three scenarios to the year 2020 cost estimates of 110-500 Kr/kg particle emissions (PM 2,5), derived from coal burning facilities outside of Copenhagen as a proxy. Although this means a clear underestimation of the health costs from emissions in street height and only particulates are calculated (no dioxins, nor PAHs etc.), retrofitting all Danish wood stoves with particle filters would result in a large positive social surplus of billions of Danish Crowns.- Even if an addition of 500 kr./kg. emission theoretically is made as for dense areas as Copenhagen, Norwegian studies with focus on Oslo still have estimated higher social costs from PM10 pollution (almost 2000.- Norske Kroner/kg).

External costs of wood burning in small units should at any rate be calculated more thoroughly to give estimates of, how big amounts of taxes should be laid upon partly their local pollution, partly their global pollution; and, accordingly, how big amounts of subsidies or other public expenditures could be used in a transitional period to reduce or substitute for this kind of energy procurement. Stem wood should be a central target of such taxes or levies, perhaps progressively according to the thickness or number of year-rings. The present tax exemptions of biomass burning should with short notice be made dependent upon the installation of flue gas cleansing devices, as they are being considered by the Danish authorities.

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[6] The International Project for the Elimination of Persistent Organic Pollutants (IPEP), see www.ipen.org coordinates civil society groups that engage in the implementation of the Convention and receives assistance from the Global Environmental Facility (GEF), the United Nations Industrial Development Organization (UNIDO), and the United Nations Environment Program (UNEP).

[7] NERI Environmental Project 1164, 2007

Relevant electrostatic or catalytic filter devices are, namely, in the finishing phase of market design as e.g. the prototype of the Norwegian firm Applied Plasma Physics developed in an EU project under the 5th Framework Programme, which probably could retain 90-98% of fine particles.[8] It is, however, improbable that this kind of filter can retain dioxins in gas phase, see end of part 3, and it is unclear whether catalytic devices will do better.

1.3 Sustainable wood burning?

Without awaiting real progress in this direction, the Danish government has in its 2007 energy plan for 2025 chosen to expand wood and straw burning to almost the double amount of 2005 and it praises wood stoves already as sustainable technology. In the Danish environmental ministry's draft version of a renewed strategy for sustainable development, launched in 2007 under the slogan "Green responsibility", wood stoves are even being made a cornerstone of sustainability politics.

This raises the question, how to control international trade with wood which according to the World Wildlife Fund partly proceeds as illegal trade via the Baltic Sea. In Denmark, a rising part of wood used for heating purposes is already being imported. Legally or not, for exporting countries in the Baltic, Poland, Russia and other places the rising export of stem wood into centre countries partly leads to overexploitation of wood resources (This makes it more than dubious to presuppose - as is done when talking about CO2-neutrality of wood firing - any equilibrium on CO2 grounds between extraction and afforestation); partly to rising wood prices. Energy planners in Lithuania complain about that, because it makes the substitution of electricity from wood fired co-generators for electricity from the Ignalina Nuclear Power Plant more and more expensive. So, the question in terms of sustainable development in the Baltic region is not only, how to evaluate the use of wood for replacing fossil fuels either in individual or in collective thermal appliances or co-generators, but also for replacing nuclear electricity. On thermo-dynamical grounds it seems, however, clear that the separate supply of electricity from nuclear power plants and of heat from individual wood stoves (as is the case in France, where the

[8] Arne Thomas Haaland 2005: End-of-pipe solution for removing respirable particles from combustion of solid fuels in domestic households. Power point presentation by Applied Plasma Physics ASA at Nordic Bioenergy Conference, Trondheim, October 25-27. Investing in 17000 filter units in the city of Oslo, Haaland figures out, could be done with a payback time of less than one year! The APP filter was also reckoned with in the cited NERI Env.Proj. 1164.

government since 1999 has given tax credits for installing wood stoves) is deficient as against cogeneration solutions.

Again, a positive score for wood stoves on the sustainability criterion seems as misplaced as it is for the CO2-emissions balances, when the implementation of the Stockholm Convention's demands upon reduction of dioxin emissions is neglected.

In repeated public campaigns, the Danish government gives people the impression, as if wood burning is a positive endeavour, if only some simple rules of firing behaviour are followed; and misuse of these uncontrollable devices for illegal combustion of waste materials is avoided. Then, the best of all worlds is realized – in eternal harmony with nature.

Contrary to this rosy picture, the following paragraphs will show analytically, how and why there is an inherent flaw with incineration technologies – both at big scale in central plants and at small scale in de-central devices.

2. Municipal Solid Waste Incinerators: the historical paradigm shift regarding formation of dioxins

2.1 Competing formulations of problems and solutions

In May 1981, I made a three week research journey to the U.S. to verify the first planned projects for combining natural gas and biogas[9], which Barry Commoner had reported about in his critique of president Carter's energy plan of 1977 (Commoner 1979, RCD 1982). When physicist Leonard Rodberg in 1983 visited our energy research group at Aalborg University, he brought with him a memorandum of the Center for the Biology of Natural Systems (CBNS) on dioxins from municipal waste incinerators (MWIs), eight of which were in the planning stage for New York City, see the website www.qc.cuny.edu/cbns.

In that first memo, CBNS responded to concerns of a citizen grass roots group with a conventional look at the formation and destruction of dioxin in incinerators, because they had not yet developed their own position on this issue. Their new position was only after consultation with chemist Theodore Goldfarb formulated in a four volume

[9] In 2007, a veritable competition was aired between E.ON and regional suppliers in Germany promoting the feed-in of biogas into natural gas networks, thus planning this technically feasible gradual transition from a fossil to a renewable fuel. Der Spiegel nr.38 and 39/2007

study of 1984.[10] It documented a ‚quantum leap' in the understanding of, how chlorinated dioxins and furans were formed within MWIs. In a veritable shift of paradigm, CBNS went away from the conventional theory of dioxin formation as being dependent upon characteristics of the waste input, of the boiler design and/or the mode of operation. Here, the crucial place of change was in the boiler section.

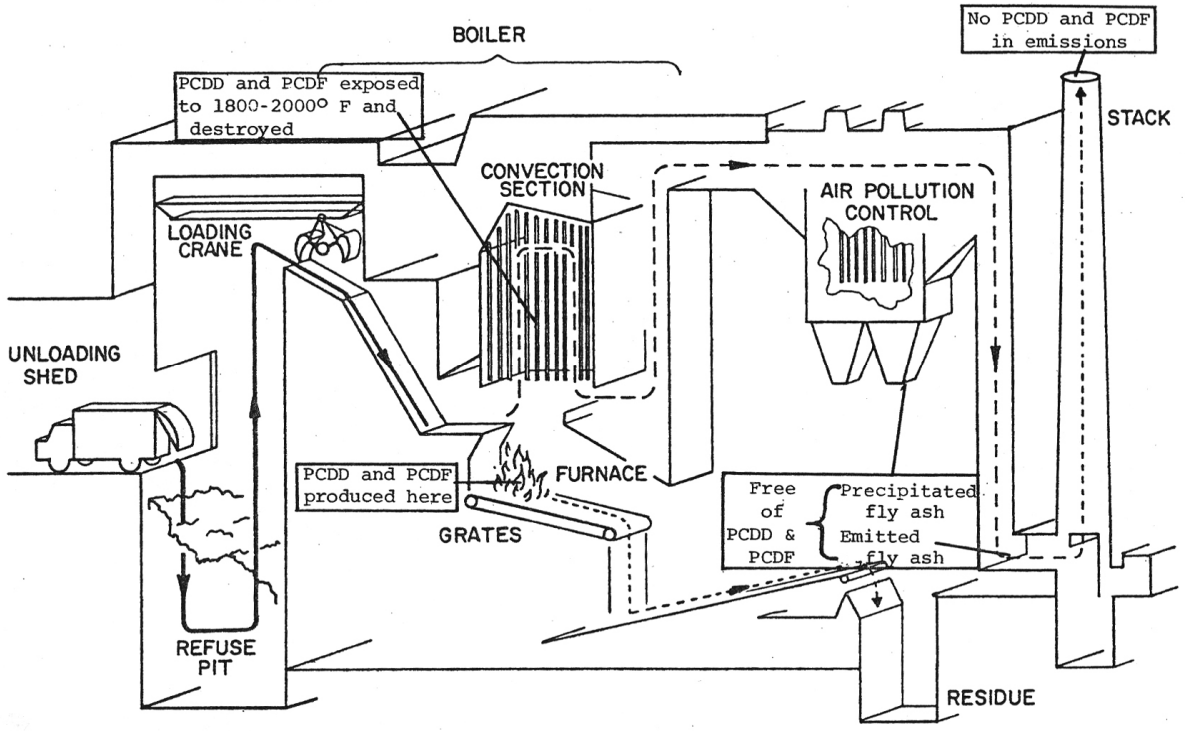
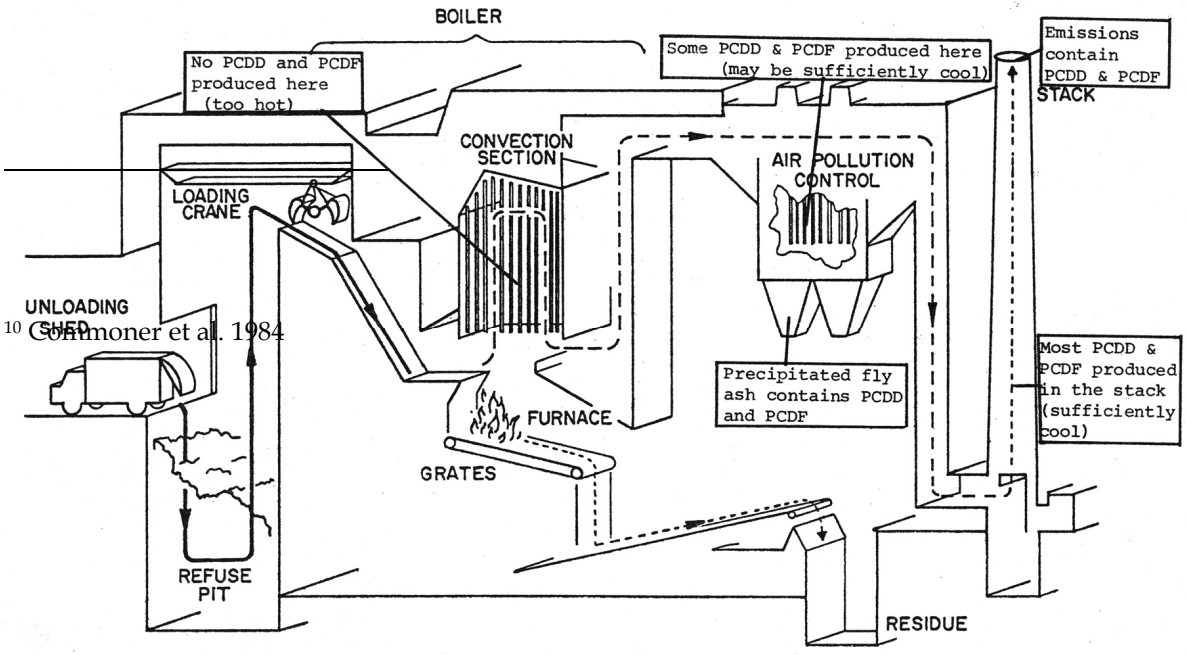


Fig. 1. ***Traditional theory of dioxin formation in a MSWI***

Source: CBNS 1984, II. Note that dioxins are destroyed by high oven temperatures

From this traditional theory CBNS went on to an alternative conception, which by adherents of the old design-and-operation-paradigm was ridiculed as the ‚chimney hypothesis'. It postulated that critical amounts of these trace chemicals were formed de-novo on the cooling path after the boiler section and eventual electrostatic



[10] Commoner et al. 1984

Fig. 2. Dioxin formation in the cooling parts of a MSWI

Source: CBNS 1984, vol.II

precipitators, which was made probable by a synthesis of experimental results on fly ash behaviour, carbon absorption and catalyst behaviour. As a result, they depicted an alternative route of dioxin formation.

Being early informed about this CBNS theory, I looked critically at the second report of the Danish Ministry of the Environment on this problem, edited in December 1984[11]. It was based upon a literature study made by a consulting firm and only repeated the old paradigm, as I noted in a 45-page critical analysis edited by our own outlet (CNAS). I had the opportunity to present these discrepancies at a meeting of the Danish Chemical Society and later the same year to publish the text within a West German regional study (RCD 1986).

After initially fierce attacks in the public from members of the Danish National Environmental Protection Agency, who defended their conventional opinions on this technical question as well as other questions of the risk assessment of dioxins, it took several years, before the former leader of the Danish task force on dioxins from incinerators at the Dioxin'88 congress at Umeå came and told me, that I nevertheless had been right in my critique. My sources weren't so bad, as postulated earlier.

Also renowned West German engineering firms and dioxin researchers of German speaking countries had by that time more or less outspoken shifted – or at least: supplemented – their paradigm regarding dioxin formation in MSWIs and saw critically at what they now called the operation-and-design 'hypothesis' (RCD 1989). In 1985, Environment Canada reported from full scale measurements at the Prince Edward Island incinerator showing that there were dioxins in the chimney section regardless of, whether there are more or less dioxins in the incinerator input, see fig.3.

2.2 Regulatory consequences

In Denmark, full scale measurements of dioxins and furans in MSWIs were only carried through in the later part of the 1980's after the ‚green majority' in the parliament had forced the government to do so (as reported in R.C.-Dupont 1988).

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[11] Rolf C.-Dupont 1985. In a first short memorandum of 1983, the Danish EPA had tried to make the problem non-existent. By political pressure which finally led to the close-down of a small incinerator at the site of a natural gas cleansing plant under construction, we had forced them to take up the issue (see RCD 1987).

When the results were published, vested interest groups ridiculed them by stating that the measured concentrations in air emissions were an order of magnitude lower than what the 1984-report of the Danish authorities had assumed based upon extreme values from the international literature. They did not acknowledge that there were much bigger uncertainties in the whole chain of risk assessment for dioxins and furans and their methodology (see R.C.-Dupont 1987). At that time, the precautionary principle was still a suppressed story and no binding norms for the end-of-pipe regulation of dioxin had been formulated.

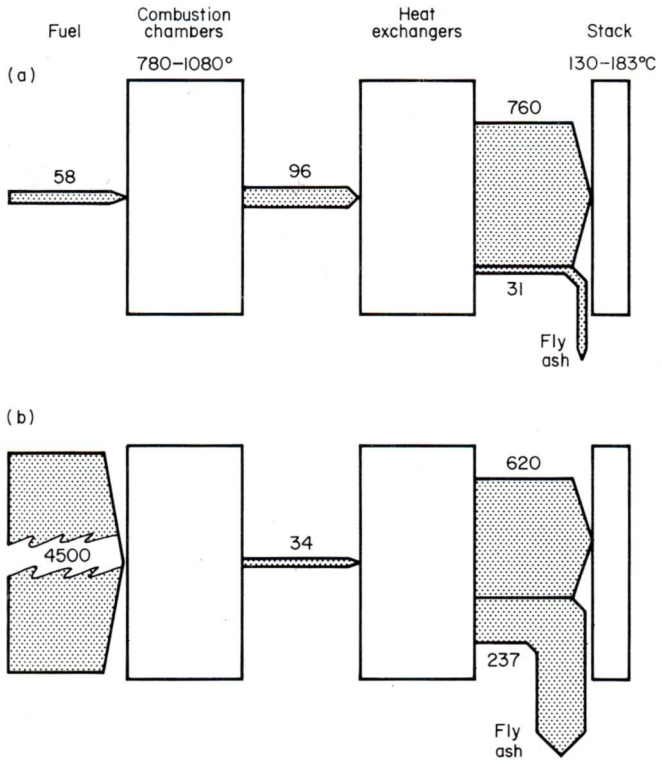

***Fig. 3.** Mass flow of dioxins and furans measured at the Prince Edward Island MSWI, Canada, from Commoner, Shapiro and Webster 1987 (all units are µg/h). Note similarity of post-heat exchanger flows despite of massively different input concentrations and effective destruction in combustion chambers.*

In the beginning of the 1990s, the European Union regulated the area of MSWIs and introduced a limit value of 0,1 ng of dioxin and furan emissions per normal cubic meter of exhaust air – notably from elevated industrial chimneys reaching up in higher parts of the atmosphere than low rise buildings in Denmark reach up to. The modernisation of MSWIs took more than 15 years to be accomplished and meant expenditures of hundreds of millions of Danish Crowns in abatement technologies. The societal willingness-to-pay had been established by the necessary political pressure both from above (EU) and from below - citizens groups in several countries had demanded intensified recycling instead of waste incineration (Commoner 1990).

The improved performance of MSWIs consisted, then, in shifting the dioxin load from emissions into the atmosphere caused by atmospheric burning to underground storages of the remaining solid waste after flue gas scrubbing (mainly with active carbon). In late 2007, complaints by Danish MSWI managers were published, when the usual deposition in German salt caverns threatened to be stopped for the Danish waste stream management - and no alternative solutions were accessible, although a growing waste stream is anticipated.

In spring 2008, a new energy agreement between parties in the Danish parliament gave allowance to power plants for co-firing with MSW in their boilers.[12] Whether they in fact can avoid an increased dioxin-emission (without installing specialised gas scrubbers) remains to be seen. At any rate, they use the de-novo-synthesis of dioxin as an argument against the conventional MSWIs – saying that this inherent flaw of these plants is relevant for infrastructural planning decisions.[13]

The controversy around these questions contributed, however, to the early introduction in Denmark of policies favouring a 'cleaner technology' approach, because it had become clear that high tech research gave crucial new insights into environmental problems, their causation and possible remedies. It had become too bureaucratic, in official documents always only to note that the authorities expected new research to decide upon how to deal with dioxin and other problems. Therefore, a new version of the Danish Law on Environmental Protection as of 1987 introduced time limits to the official licensing of hazardous industrial or infrastructural assets. When new licenses were due, the authorities could introduce results of new research and/or technological development as a demand for giving the permits. One could hope that this progress also will be made with regulations of small wood burning installations.

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[12] In March 2008, a report was announced from a Danish consultant firm which will support the views of the DONG energy company that it is preferable to burn MSW in their power stations, i.a. with the environment argument that traditional MSWIs produce dioxin de-novo, but that this is not happening in power plants because of a different 'chemical environment'. Ingeniøren on-line March,19 2008 (by Andreas Antoni Lund)

[13] See the footnote after fig.2

3. Formation of dioxin in wood burning installations

In this section, I have chosen an indirect approach starting with the presentation of a forerunner case which might be used as a precedent for coming local conflicts. Then, a discussion of the scientific-technical content of the dioxin issue is making the feed-back to the main thread of our argument. And the dilemma in relation to the normally known other pollutants from wood stoves is discussed.[14]

3.1 Case Hyldebjerg/municipality of Kirke Hvalsø/Lejre, Zealand

The Danish ‚Elsparefonden' (and other energy authorities) promoted in the 1990s financially and by strengthening organisational and commercial infrastructures the substitution of water based heat supply from district heating co-generators for electrical resistance heating. When the city of Kirke Hvalsø in Mid-Zealand succeeded in renovating its district heating scheme and had substituted natural gas for oil coupled with electricity production (originally proposed in the course of a regional energy campaign by Hovedstadsraadet), a local initiative for substituting this district heating for electrical heating in the 70 row houses of Hyldebjerg got subsidies from Elsparefonden and went under way in late 2000[15].

Of the 70 housing units about 2/3 chose this collective problem solution, others continued with electricity heating hoping for low prices as a result of energy liberalisation and still others changed over to intensive use of wood stoves – not only as comfort ('hygge'), but as main source of room and even water heating. An aggressive sales strategy for wood stoves led to the addition of a couple of cheap stoves with short chimneys to the then existing 10 stoves (often only partially or very seldom used). The short chimneys were placed on the garden side of houses in row 4 and 5 (reckoned from S) and ended more than 1 m under the roof top – in short distance from roof windows of Velux type. These windows have small parts to be opened for air conditioning in these tightly isolated dwellings (because of electricity

[14] Fact shets, hot spots and technical as well as practical-political arguments for severe regulation and substitution of wood stoves are assembled (mostly in Danish) by Solveig Czeskleba-Dupont . Contact: sd@cnas.dk. A Working Paper (in Danish) on "Smoke from wood stoves and air pollution – measurements and evaluations" (23 p.) is also available.

[15] Because of insight into the thermo-dynamical waste of electrical resistance heating (not according to first law efficiency, as originally argued in the Danish energy debate, but according to second law efficiency or entropy), I had begun to organize neighbors as early as 1990 for this project, but at that time there was only support for information campaigns from the 'Green families' project.

heating as design parameter). Some houses have even mechanical ventilation to undo with problems of water condensation.

Now, the low chimneys emitted their exhaust air continuously to one side of the roof area – also when fall-out from other, higher placed chimneys was hitting the other side of some houses. Here, the situation could result that there was no access altogether to fresh air for the neighbours concerned e.g. in evening time.

The municipality of Hvalsø (now part of Lejre Kommune) had delegated the control with wood stove installations to the local chimney sweep and tried to make a cover-up on this deficient placing of low chimneys,[16] when a meeting was organised at the municipality between the contesting parts in this conflict. The responsible politician supported the views of the chimney sweep, who on his part threatened to go to courts because of wrong accusations against his decision.[17] But in substance, he admitted that he only controlled the inside conditions and the constructive setting-up of the chimney and not any environmental effects. As he told, God would take responsibility for the environmental fate of the smoke. And indeed: the emissions from wood burning are too chaotic to follow an easy pattern – both regarding formation of toxics and their environmental fate – if nothing is done to effectively improve that.

Only in 2003, after three years of complaints, the municipality forced the two owners of wood stoves with low chimneys (who since have left the neighbourhood) to heighten these so that they emerged at almost 1m above the roof tops. And this happened only after concerned neighbours had presented the minister of environment for a 50-page documentation[18] of all aspects of the case, including a 2-page statement of the medical officers at Roskilde County. They had, namely, demanded "*to stop or bring under control the air pollution caused by smoke from low chimneys in the row house quarter of Hyldebjerg, so that it does not elicit detrimental health effects, strains or damages*." This suspicion was based upon the presumption:

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[16] Local authorities continued to misinform citizens by distributing a leaflet form 1984, when rules for placing chimneys had been liberalized, even when more restrictive rules had been defined in the late 1990s.

[17] The juridical situation was, however, that both the chimney sweep and Hvalsø municipality were wrong in relying on an old de-regulation from 1984 (widely publicised in municipalities, who were the 'court' of last resort in these questions), whereas stricter re-regulations had been in effect in the late 1990s.

[18] Solveig Czeskleba-Dupont 2002: Røgsagen Hyldebjerg

"Depending upon the kind of material burned, the burning temperature and its control smoke can contain different substances that may be detrimental for good health. Smoke contains inter alia big amounts of PAH (Polycyclic Aromatic Hydrocarbons) that can cause cancer." [19]

As side conditions for assuming unacceptable strains on the neighbourhood the medical officers stated: "Based upon the descriptions of the complaining parties, it is the case in the indicted circumstances that a) the smoke impact periodically can be strong and persistent, and b) that the persons exposed to the smoke are unable to avoid or limit their exposition to the smoke by own behaviour." Note that this regularly is the case in neighbourhood relations – in contrast to open fire places at social gatherings, where people can move away from pollution.

Short time after the ministry of environment had received the case documentation, Hvalsø municipality changed attitude and used their decision making power to enforce a normalising ‚lift-up' of the two chimneys concerned. This represented a half success, in that the repressive attitude of most of the old municipalities in Denmark against complaints about wood smoke was set aside. [20] It was only half a victory, yet, because this normalisation showed to be ineffective in the setting of this densely built-up community e.g. with dividing outer walls between the entrances of each of the 7 houses in a row that contribute to eddies hindering *free dilution of exhaust air* – which, otherwise, is a normative demand according to clean air regulations in Denmark.

The spontaneous formulation of the 2-page-memorandum by the medical officer at Roskilde County has apparently been a seldom initiative which according to our knowledge as yet not has been repeated in Denmark. In environmental politics, it has

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[19] The concentration of PAH in emissions from wood stoves, which have been measured in Denmark, lies far above the limit value of 0,005 mg Benz(a)pyren, which hast been stipulated in the Danish Clean Air Guidelines. Wood stoves have become the all-overwhelming source of PAH in the environment of Denmark (over 90%). It has to be added that individual sensibility as against PAH depends upon genetic factors in combination with physiological processes, as I have said in my Intervention Paper 'Public Health ' (RCD 2006) : "Fabig 2005 identifies as a deficit connected with one GSTM1 gene variant that people characterized by that variant are not able to detoxify benzo(a)pyren, the lead substance of poly-aromatic hydrocarbons."

[20] According to environmental law, municipalities are sovereign to decide these matters, which was often done by the political leadership more than the environmental technicians. It remains to be seen, how the new Danish municipalities of 2007 use their enhanced competencies to delimit areas for special control of wood smoke pollution (Bekendtgørelse of 2008).

the value of a whistle-blower statement. Analytically, it was characterised by restraint, however, because the argument was only built upon the known properties of PAH and not upon the much more controversial issue of dioxin contamination.

Since the first half of the 1990s, research reports of the Danish EPA had given clear indications of the existence of chlorinated dioxins and furans in the exhaust gases from experimentally driven wood stoves, i.e. experiments which excluded the use of contaminated inputs.[21] And in April 2002, the official journal of the Danish EPA called "New Knowledge from the Environmental Agency" presented a follow-up investigation by Force Technology under the designation of Denmark as being "lead country" within the OSPAR Convention for research in dioxin issues.

The medical officers at Roskilde County had, otherwise, been informed about this new knowledge together with my interpretation of critical indications in the 2001 report of Force Technology itself[22], which were not reported in the official summary view in the journal, see the following.

3.2 New knowledge on chlorinated dioxins and furans from wood stoves[23]

The report of Schleicher et al. 2001 validated earlier published experimental data of 1994[24] and confirmed by way of their own experimental set-up that the mentioned limit value of the EU for industrial and incinerator chimneys (sic!) again was surpassed up to a factor of 8. The same order of magnitude of emissions of PCDD/F has been measured time and again in systematically designed field measurements at the top of single family dwellings in the suburban city of Gundsømagle near

[21] Internationally reknowned is the report of Hansen, K.J. Vikelsøe, J. & Madsen, H. (1994): Emission af dioxiner fra pejse og brændeovne. Miljøprojekt nr. 249.

[22] Schleicher, O, Jensen, A.Astrup & Blinksbjerg, P. (2001): Måling af dioxinemissionen fra udvalgte sekundære kilder. Miljøstyrelsen , Miljøprojekt nr. 649

[23] En ajurført beskrivelse af de vigtigste måleresultater og deres vurdering findes i: Solveig Czeskleba-Dupont 2008

[24] Hansen, K.J. Vikelsøe, J. & Madsen, H. (1994): Emission af dioxiner fra pejse og brændeovne. Miljøstyrelsen, Miljøprojekt nr. 249.

Roskilde[25]. The home owners knew of the measurements and have surely not misused their appliances.

The difference between the dilution of exhaust gases from industrial and incinerator chimneys, that reach perhaps 100 m higher parts of the atmosphere with mass streams that are much more intense than given at low level wood firing installations, and the dilution possible from these wood stoves stretches probably over several orders of magnitude. The Danish NERI researcher Poul Bo Larsen has estimated a dilution factor of minimum 10 000 as necessary in order to dilute PCDD/F to background air contamination levels.[26] This also is a dilution factor reckoned with in dioxin risk assessments for the (high) chimneys of MSWIs.

Therefore, the protective meaning of the EU limit value for chlorinated dioxins and furans based upon much more favourable conditions regarding dilution is totally violated by the emissions from normally functioning wood stoves in street height.[27] This requirement is clearly undercut in real life conditions, where it is known that outdoor concentrations of contaminants are almost completely reproduced as indoor

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[25] Glasius, M., Vikelsøe, J., Bossi, R., Andersen, H.V., Holst, J, Johansen, E. & Schleicher, O. 2005: Dioxin, PAH og partikler fra brændeovne. Danmarks Miljøundersøgelser. 27 s. Arbejdsrapport fra DMU nr. 212.
http://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR212.pdf.

And: Glasius, M., Konggaard, P., Stubkjær, J., Bossi, R., Hertel, O., Ketzel, M., Wåhlin, P., Schleicher, O. & Palmgren, F. 2007: Partikler og organiske forbindelser fra træfyring – nye undersøgelser af udslip og koncentrationer. Danmarks Miljøøundersøgelser, 42 s.- Arbejdsrapport fra DMU, nr. 235
http://www2.dmu.dk/Pub/AR235.pdf

[26] Poul Bo Larsen, Danish NEPA:Power-point show at the conference on Air pollution, wood smoke and public health, arr. by the Association for Environment and Public Health, Panum Instituttet, Copenhagen, 25.1.2006 . Poul Bo Larsen referred to Schauer et al. (2001): Env. Sci. Techn. 35, 1716 -1728 og Gullett et al. (2003): Env. Sci. Techn. 37, 1758 – 1765.

[27]The report of the Danish National Environmental Research Institute (NERI Environmental Project 1164, 2007) on 'Brændeovne og små kedler – partikelemission og reduktionstiltag' (Wood stoves and small boilers – particle emissions and reduction measures) admits, thus, that its use of cost estimates of 110-500 Kr/kg particle emissions (PM 2,5), derived from coal burning power plants outside of Copenhagen, is a clear underestimation of the health costs from emissions in street height.

concentrations. This means that whole neighbourhoods are poisoned chronically by low doses of these ultra-toxics.[28]

Application of genetic diagnostics has shown today that people with unfavourable gene variants, who may be some of the neighbours, cannot repair the damage done between cycles of intoxication.[29] Damage estimates which are taken into cost calculations have to take this complication into consideration…

The toxic freight from wood stoves has at any rate been systematically underestimated, as this consideration of the dioxin problem alone shows in a nutshell. One mechanism of, how this scandalous state of affairs is being maintained, is immediately to point at misuses of wood stoves as waste incinerators, as e.g. the experienced researcher Thomas Nussbaumer did in 2005. In a survey article[30], he focused upon wrong inputs to wood stoves and problems of operation conditions, although he initially stated that the 'de-novo-synthesis' of PCDD/F is regarded as "the main source of PCDD/F-emissions with thermal processes" (43). He does, however, not investigate this mechanism with wood stoves in clean conditions (as the Danish studies cited above) as an alternative to input contamination. This clearly plays a big role in the case of misusing wood stoves as waste incinerators: The oven temperature does not reach the high levels of MSWIs, which means that the incoming dioxin freight is not reduced, as in fig.3 on Environment Canada's measurements, shown above, and would rather add to de-novo concentrations synthesized in the wood stoves. On analytic grounds, the illegal use of wood stoves has, however, to be treated separately from the question, which inherent

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[28] Precisely how toxic low doses of dioxin in this kind of exposure are, is not established analytically. Risk assessments for PCDD/F are still controversial, but serious evidence supports the position that there is no lower threshold of toxic effects in humans (RC.-Dupont 1987 and 2007). Outdoor dioxin concentrations have also been measured in several reports from NERI showing clear differences of areas with wood stoves and background contamination.

[29] Rolf Czeskleba-Dupont 2006: *Intervention Paper Public Health*, Thematic Network SUSTAINABILITY STRATEGY www.sustainability-strategy.net. See also Schnakenberg, Fabig et al. 2007.

[30] Thomas Nussbaumer 2005: PCDD/F-Emissionen aus der illegalen Abfallverbrennung – Einflussgrössen, Korrelationen und Konsequenzen für Holzfeuerung. IMMISSIONSSCHUTZ, nr.2, 43-49. The mentioned presentation of Schleicher et al.2001 in "New Knowledge from the Environmental Agency" April 2002 has also been accompanied by other articles focussing upon the misuse problem, as does the (mis-)information campaign of the Danish authorities on pollution from wood stoves, which gives people the impression that everything is o.k., if only they follow some hints of how to do the firing (in TV assisted by chimney sweeps showing practical details).

contaminations result from the technology itself, normal wood input taken into consideration.

Regarding the normal mode of operation, the experimental set-up of Schleicher et al. 2001 resulted in another, symptomatic result. Besides varying wood input (one variant with bark, the other without), the input portioning was differentiated in two six hour test runs by more or less packing, a variant with 5 kg portions at a time being called 'night firing', the other with 5 x 1,9 kg 'normal'.

Table 1. ***Dioxin emission from a 5 kW wood oven extrapolated in reference to tons of input (left) and to cubic meter of air output (right: normal, dry conditions with 10% oxygen)***

	Normal firing ng I-TEQ/t wood Average of two tests	Night-firing ng I-TEQ/t wood Average of two tests	Normal firing ng I-TEQ/m3 (n,t,10%O2) Average of two tests	Night-firing ng I-TEQ/m3 (n,t,10%O2) Average of two tests
Birchwood	5100	610	0,76	0,09
Beachwood	1900	640	0,28	0,10

Source: Schleicher et al. 2001

As is evident from the test results, the difference in effect between the two modes of operation is especially high, when firing with bark than not doing so, but even without bark (pure stem wood) it remains at around a factor of 3. The average level of concentrations is almost equal with night firing. Here, it is around the limit value for MSWIs (0,1 ng I-TEQ/m3), whereas it exceeds it by a factor of almost 8 in case of birch (+bark) and almost 3 in case of beech (minus bark).

These measurements, thus, indicate a fundamental operational dilemma of this type of ovens: at optimised 'normal firing' conditions emissions of dioxin are manifold bigger than at the otherwise sub-optimal mode of 'night firing'. As the authors say, night firing cannot be recommended, because it translates into an essential increase of emissions of CO, PAH, smells and other pyrolitic products of wood combustion which are not destroyed when oven temperature is too low:" With this mode of operation, only 112 ^{O}C were measured at the chimney outlet, whereas normal operation yielded 264 ^{O}C." Here, temperature was raised up into the critical level, at which catalytic processes occur that are required for the de-novo-synthesis of PCDD/F – processes which it had taken a paradigm shift to be acknowledged systematically in the study of dioxin formation in MSWIs; and which the report of Schleicher et al. 2001 only gives some indirect indication of.

They admit that they went into a paradox, when experimentally studying the functioning of the wood stoves: „Against expectations, night firing shows a lesser emission of dioxin than normal firing. The conditions of combustion lead to worsened incineration which means increasing CO-emissions and according to our expectations would lead to an increased formation of dioxins. The causation of the opposite can be traced back to the essentially lower combustion temperature, which may be too low in order to lead to the chemical reactions which are necessary to the formation of those precursors and chlorine radicals which take part in the formation of dioxin. The lower speed of incineration (5 kg instead of 9,5 kg in six hours) means less combustion air, which presumably leads to lessened turbulence in the combustion zone and thereby to an enlarged possibility of local oxygen deficiency in the combustion zone, which could contribute to lower dioxin formation, because oxygen is a precondition fort he formation of dioxin." (Schleicher et al. 2001, 38)

The 'lead country' analysts knew presumably the corresponding debate on dioxin formation in MSWIs which have led to the recognition of dioxin formation de-novo in the cooling phase. But they only talk about a precursor causation which according to Nussbaumer 2005 is the other one of three causation mechanisms (input, de-novo synthesis and precursor combination). Seen from the older learning process, it is astonishing that Schleicher et al. at all had maintained the expectation of the early 1980s of dioxin formation being parallel to normal signs of incomplete combustion. Hereby, the illusion is propagated – as was initially the case in the MSWI debate - that it will be possible to cure the problem by progress in oven design and firing technique – an expectation which is central for the continued prosperity of the oven producing establishments and trade firms and thus for governments, who don't dare engulf themselves in selective industrial policy.

Instead, the Danish government wants to further a new wind mill adventure by creating positive conditions for the export of wood stoves e.g. to countries like Norway and France[31]– countries which don't engage in electricity and heat cogeneration. It is strategically uplifting this project by integrating it into its strategy for sustainable development (Grønt ansvar) and putting millions of tax payer Crowns into improved research and development of these gadgets. On top of that, the new departmental order on wood stoves of 2008 is designed so that the environmental evaluation of this marvellous technology a priori is prohibited to contain any hints at alternatives to reach the same purpose (lifting room temperature to around 21 ^{o}C), which might score better on environmental criteria.

3.3 Additional pollutants from wood stoves- a dilemma

Already in 1980, research efforts on pollution from wood stoves were published: „If the environmental effects of residential wood burning are any indication of things to come, the large-scale development of bio-energy may be fraught with problems."[32] A study carried out by Monsanto[33] Research had "found very high levels of polycyclic organic matter (POM) pouring out of two wood stoves and a fireplace that were

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[31] Børsen, Vækstdanmark, 12.2.2008

[32] ES&T Outlook 1980: Bio-energy - the lesson of wood burning? ENVIRONMENTAL SCIENCE & TECHNOLOGY, vol.14, no.7, July 1980, 769-771

[33] It is not surprising that Monsanto as one of the chemical firms involved in delivering dioxin-contaminated herbicides to the U.S. and South Vietnamese forces did not report on chlorinated dioxins from wood stoves, see chapter 6.

studied. Included among the POM were benzo[a]pyrene and several other known or suspected carcinogens." (769) Although the stoves were "operated under proper conditions", it showed that "carbon monoxide and POM emission rates…were an order of magnitude higher from the stoves than from the fireplace". Because slow burning means greater thermal efficiency, it was concluded that "the (then observed, rcd) rush to switch from fireplaces to the more (energy, rcd) efficient, air-tight wood stoves has in fact accelerated the problem"(770) regarding toxic emissions. Already at that time, several regions and states in the U.S. tried to restrict the increasing pollution from wood stoves by stricter regulations or technological substitution.

Environmental control authorities of the state of Washington have since 1992with updates in 1997 and 2004 issued a comprehensive list of toxic components in wood stove emissions comparing its health hazards to those of cigarette smoke.[34] The brochure which is available on-line[35] contains both cross-disciplinary, analytically relevant problem descriptions and explanations and proposals how to deal with thick air.

Not only the Danish NERI has, thus, published data and insights into a whole spectrum of pollutants from wood burning that at least comprises dioxins, PAH and (ultra-)fine particles – the latter down to nano size. Especially detailed studies of smoke particles over time from start of incineration have been published by the Australian environmental authorities. They show that through a period of several hours the particle composition as measured in number changed from particles with a geometric mean (representing a lognormal distribution) of around 0,2 µm in the start phase to around 0,05 µm prevailing through several hours.[36] One of these test runs, comprising only 1 ½ hours, is shown in fig.4a.

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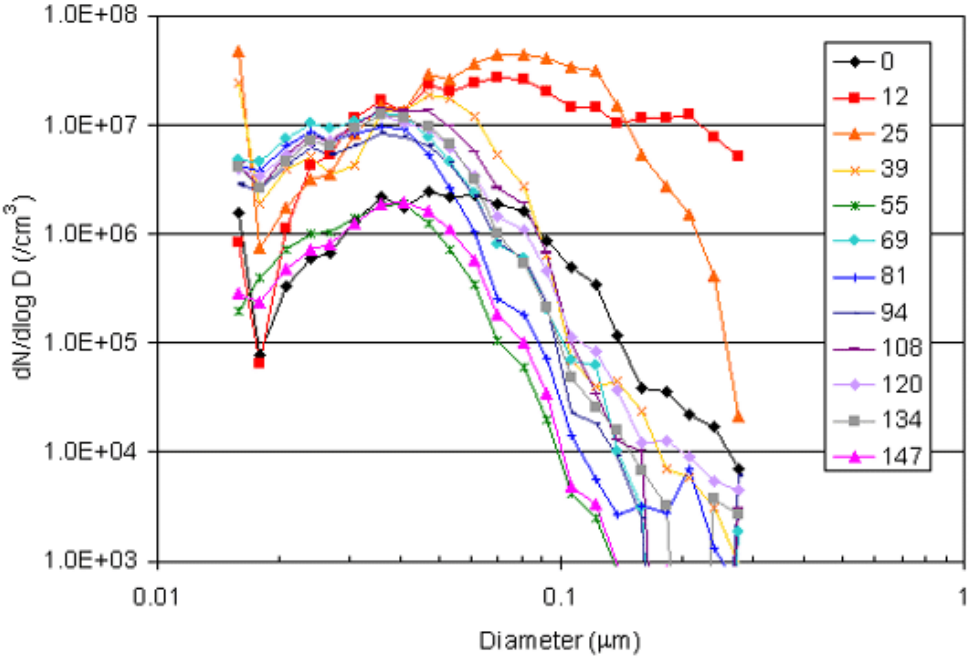
[34] Washington State Dept. of Ecology 1992 (updates 1997, 2004): Health effects of wood smoke. Author: Jamie Craighill

[35] at www.ecy.wa.gov./pubs/92046.pdf (15 pages)

[36] Environment Australia (2002): Technical Report No. 5: Emissions from Domestic Solid Fuel Burning Appliances. (ISBN 0642548676) (www.ea.gov.au/atmosphere)



= EA 2002, fig. 60. Aerosol size distributions for AS4013-compliant heater C2, green redgum (water = 33.8%), high flow (sample #39). Values in the legend are minutes after loading fuel.

Fig. 4a. ***Aerosol emission rate (number N) per cubic centimetre of exhaust gas from wood burning against log-size distribution shown in different time snapshots after start of incineration***

Source: Environment Australia 2002

The Australian report[37] concludes inter alia, that

particle-emission mass correlates with water content of fuel,

the biggest particle emission measured in weight emerges at the lowest efficiency of burning,

control of particle emission measured in weight can control most of the emissions of chemical

compounds as e.g. PAH, but this does not apply for neither nitrogen oxides nor dioxins

[37] Environment Australia (2002): chap. 10, Summary and conclusions

emission of dioxin increases, on the contrary, when emission of particles is reduced.

Regarding control of dioxin the Australian authorities formulate a direct falsification of the design- and operation hypothesis:"Two clear exceptions are nitrogen oxides and dioxins, where it appears that heater design or operation parameters that reduce aerosol mass emissions work to increase the emissions of these species."[38]

There is thus, no analytical support for the strategy of the Danish environmental authorities (backed up by the whole government) to try to reduce dioxin contamination of the environment from small wood burning devices by modernising wood stoves only with one parameter at hand, namely a lowering of particle emissions. The authorities maintain that by modernising the mass of wood stoves the total of particle emissions to the Danish environment can be reduced by 25% until 2020.

But not even this small improvement can reduce dioxin emissions – on the contrary they might even be increased, if the conclusions of the Australian authorities are valid.

4. Devalued CO2-neutrality of stem wood combustion:

Enlarged CO2-emissions increase the greenhouse effect in short to medium run

4.1 Basic insights

In relation to the accumulation of CO2 in the Earth-atmosphere physicist Bent Sørensen has characterised the time effects of burning biomass in the following, differentiated way:

"Concerning carbon dioxide, which accumulates in the atmosphere as a consequence of rapid combustion of fossil fuels, it should be kept in mind that the carbon dioxide emissions during biomass combustion are balanced in magnitude by the net carbon dioxide assimilation in the plants, so that the atmospheric CO2 content is not affected, at least by the use of biomass crops in fast rotation" – which approximately is the case with energy plantations.

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[38] Environment Australia (2002): chap. 10 (Summary and conclusions), summary regarding "Wood-heater emissions and their controlling factors" (or: not controlling, rcd)

This idea of complete reversibility between emissions and binding of CO2 in the course of the destructive burning and regeneration of biomass has led to the concept of CO2-neutrality of its incineration. In this sense, governments who are implementing the Kyoto Protocol have made operational rules for energy accounting[39] so that earlier ways of registering emissions of CO2 from different sorts of biomass have been replaced by setting in Kyoto context these emissions to 'zero' from the very beginning.[40]

This implies a problem however, when done without differentiation regarding plant turn-over times. Bent Sørensen adds, thus, a decisive condition, when taking account of crop rotation time. In negative terms, he continues: "The *time lag for trees* may be decades or centuries, and in such case the temporary carbon dioxide imbalance may *contribute to climatic alterations*."[41]

The argument of CO2-neutrality lacks, thus, validity when stem wood is burned which results in a disproportion between the amount of CO2 released within a time interval, say a year, and the fraction of CO2 bound in plant growth within the following time interval of same length. Consumers, especially importers, of the wood have in a market economy – and this is the constitution of the world-market - no guarantee for a binding of equal amounts in due time. So, a time-lag emerges which means that there is a critical flaw of the argument which is decisive in a situation, where the cumulative CO2-emissions must be reduced within one or two decades in order to reverse the rising trend in global warming. The thinking in reversible patterns of time (cycles) has, in this historical juncture, to be combined with thinking in irreversible time trends[42].

If governments nevertheless continue to make CO2-accounting on the premise of CO2-neutrality for all biomass burning, they act as those agencies giving "offset indulgences for Your climate sins", as Carbon Trade Watch has formulated it.[43]

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[39] At the Marrakesh COP VII (2001)

[40] Whereas reports to the original Climate Convention still contain CO2 emission factors for biomass sources, see table 2 below.

[41] Bent Sørensen , 3d ed., 2004: Renewable energy, Academic Press, p. 483 (italics rcd)

[42] This combination is decisive for historical sciences, see the arguments of Immanuel Wallerstein 1991, 260f.

[43] Kevin Smith 2007: The Carbon neutral myth. Offset indulgences for Your climate sins. Carbon Trade Watch and Transnational Institute (ISBN 9789071007187)

An analytical opening of the concept of CO2-neutrality has also been intended by the British energy and environment researcher David Elliott of the British Open University. In a recent publication of the British Royal Society of Chemistry on „The environmental impact of renewable sources of energy", he declares: "Specially grown energy crops are…usually seen as attractive options by most environmentalists…". And he added as a necessary condition:"…*as long as the rate of use is matched by the rate of replanting to maintain rough overall carbon neutrality*."[44]

This match should, however, be carefully demonstrated in the case of wood burning and equivalent plant growth in order to define 'break-even-points' between emissions and re-binding of CO2, perhaps measured as the product of mass of plants and time elapsed. It is reasonable, however, to be sceptical, in that the burning of wood (and in much lesser degree also straw) – even when substituting the burning of fossil fuels – leaves a negative net balance of emissions, because its use to accomplish a given amount of heat effect releases more CO2 than most fossil fuels do (almost 80% more than natural gas). See table 2 (next page).

Note that the binding of emitted CO2 in the following growth seasons has not only to cover the extra amount released (80% more than the natural gas crowded out), but also the principal amount. Even crops in a *few* years rotation will result in a time-lag of balancing emissions by newly-bound amounts of CO2. This time-lag will be amplified many times, when new growth happens by reforestation with lead times of decades or centuries. So, there is emitted an excess amount of CO2 that is worsening the global climate problem, when wood burning is expanded, as Danish NERI reckons with. In a 2007 report on GHG emissions until year 2030, NERI has, thus, projected a doubling of wood combustion (not only from private residence use)[45]. It is wrong to evaluate this expansion as CO2-neutral renewable energy, because it quite on the contrary will contribute further to the atmospheric build-up of an accumulating carbon debt and thus contribute to global warming.[46]

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[44] David Elliott 2002, 31.

[45] NERI Technical Report 611: Projection of GHG emissions 2005-2030, Table 2.2, p.21

[46] …as do the black carbon particles from South East Asian forest fires (man-induced or not) which NASA has traced to move high up into the atmosphere so that they are transported via the Bering Street to the Arctic, where its depositions contribute to the melting of the ice surface – deplored not the least by the Danish governmental authorities who at home recommend wood burning as sustainable…

David Elliott has, furthermore, developed the concept of an "energy flow functional analysis" which not only can be applied to "'flow'-type renewables like wind, hydro and wave power", but also „*'stocks' of renewable energy, such as biomass.*" In the latter case, however, "the issue…becomes the *ecological value* of the material being used, rather than just its energy value. Although it can be carbon neutral if the rate of burning is balanced by the rate of planting, the use of biomass has potential impacts, both from *emissions* produced by its combustion and because *combustion destroys valuable organic material*…problems…shared by combustion of solid domestic and municipal wastes…On the basis of this functional analysis, the main problem could be the sterilization of valuable organic material".[47]

[47] David Elliott 2002, 41

Table 2. ***CO2 emission factors from different fuels as reported by Danish NERI.***

Appendix 3A-4 Emission factors

Table 3A-29 CO_2 emission factors.

Fuel	Emission factor		Unit	Reference type	IPCC fuel
	Biomass	Fossil fuel			Category
Coal		95	kg/GJ	Country specific	Solid
Brown coal briquettes		94.6	kg/GJ	IPCC reference manual	Solid
Coke oven coke		108	kg/GJ	IPCC reference manual	Solid
Petroleum coke		92	kg/GJ	Country specific	Liquid
Wood	102		kg/GJ	Corinair	Biomass
Municipal waste	94.5	17.6	kg/GJ	Country specific	Biomass / Other fuels
Straw	102		kg/GJ	Country specific	Biomass
Residual oil		78	kg/GJ	Corinair	Liquid
Gas oil		74	kg/GJ	Corinair	Liquid
Kerosene		72	kg/GJ	Corinair	Liquid
Fish & rape oil	74		kg/GJ	Country specific	Biomass
Orimulsion		80	kg/GJ	Country specific	Liquid
Natural gas		56.96	kg/GJ	Country specific	Gas
LPG		65	kg/GJ	Corinair	Liquid
Refinery gas		56.9	kg/GJ	Country specific	Liquid
Biogas	83.6		kg/GJ	Country specific	Biomass

Source: NERI Technical Report Nr. 632, Denmark's National Inventory Report 2007 to UNFCCC

4.2 Wood products back in

Besides the criterion of CO2-neutrality, which is violated by the combustion of stem wood today, the latter contributes to another ecological debt post by the mineralisation of valuable tree, insofar as this could be used for other, materially non- or less destructive applications. Already in its Third Assessment Report, the Intergovernmental Panel on Climate Change put real historical time into considerations of the kind, we have cited above, saying: "*Natural processes and management regimes may reduce or increase the amount of carbon stored in pools with turnover times of the order of tens to hundreds of years (living wood, wood products and*

modified soil organic matter) and thus influence the time evolution of atmospheric CO2 over the century." [48]

In its Fourth Assessment Report of 2007 IPCC makes the idea of monitoring changes in storage pools operational by recommending to registre wood use both for energy purposes and in the shape of materially conserved products.[49] And a vague hope is spoken out, that despite more short-sighted claims on wood use "*the climate mitigation benefits of sustainably harvested wood products are more fully recognized*."[50]

The alternative of materially destructive versus constructive uses of wood biomass is not absolute, because some wood waste will be burnt because of practicality. But alternative uses are also being improved e.g. in manufacturing chip board which now can be laminated with artificial laser prints and use less harmful types of glue substituting formaldehyde. But the priorities in society seem still to be up-side down, as argued by Barry Commoner in the introductory pages of his ‚Poverty of Power'.[51]

Without lengthy arguments concerning the societal evaluation of natural resources[52] the following argument can be made with close regard to our problem: If it is right that a massive rush into stem wood burning is being caused by rising oil prices, it seems also clear that society has to consider an increased use of wood in applications, where this material in periods of cheap oil has been out-crowded by plastic products. [53] Once we come under way with this exercise, it cannot be done without introducing new technology and new uses for wood. The root problem is, then, how to foster sustainable development in wood resource exploitation by bringing it into harmony with the orientation of technological development, the direction of investments and institutional change.

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48 IPCC: Climate change 2001, Working Group I: The Scientific Basis, ch. 3.2.2.1(italics rcd)

49 This difference is apparently neglected by the Danish research program on Wood Use (administered by NERI), being dominated by irrational interpretations of burning wood as a life style priority dating back to the ancestors' lucky times in harmony with nature.

50 IPCC, Fourth Assessment Report, WG3 on wood, §9.6.4 (italics added)

51 Barry Commoner 1976: The poverty of power. Energy and the economic crisis. New York; for details see Rolf C.-Dupont 2006: Energy policy and politics for sustainable world-system development. SUSTAINABILITY POLITICS, ed. by F.O.Wolf, Working Paper #17.

52 For a substantial contribution coming form one of the founders of ecological economics connected with political ecology, see e.g. Joan Martinez-Alier 2002 on conflicts of valuation.

53 Such re-substitutions are discussed in Commoner 1992

In this relation it seems fair to say: Investments in wood stoves are erratic aberrations in relation to both a sustainable orientation of technological development and a sustainable exploitation of biomass resources. The observable trend to favour them politically is grounded in a deficit of politics, where a deep market failure to internalise serious external costs is not corrected, but post-rationalised by dogmatic reasoning to be a virtue ("sustainable"). Instead, in accordance with the analytic definition of sustainable development, institutional change should aim at more strict regulations and goal-oriented steering of this sector of our life sustenance.

4.3 Realistic research is necessary and possible

The lack of necessary political leadership is also evident at the EU level. In the design of policy measures, the said difference between stem wood on the one hand and energy plantations or the harvesting of crops in short rotation on the other has been neglected. In the Commission Communication COM(2005)628 final on an Action Plan for Biomass the materially destructive use of biomass for purposes of room heating is not seen as a problem at all. On the contrary, this action plan only repeats market illusions about low costs of applying biomass sources to heating purposes.[54]

This is done, although earlier research in the EU context as e.g. the renowned project ‚Extern E' clearly indicated that wood burning causes external costs of around 7,5 cent per KWh which is a factor three above coal heating. Also, any reference to the EU legislation on particle emissions is lacking, although the origin of particles from traffic sources and from wood burning can be traced analytically, as is known internationally. In Denmark, an interesting cross-fertilisation is developing, where research on particle pollution from traffic sources has been productive for promoting the equally important question of health costs associated with wood burning – in Denmark a more important source than traffic.

Instead of expanding the burning of wood, a reasonable strategy for the energy transition should aim at reducing it. Arguments for this choice could be made transparent by better accounting of CO2-emissions from wood burning for heating purposes. They must be generally included in accounting for climate change by extending the decision of the Bali December 2007 climate summit regarding the destruction of tropical forests to both destructive and constructive uses of wood from other forests, too. And they should be studied more intensely, as e.g. the Australian environmental authorities have done, see fig. 4b (2 parts).

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[54] See section 1.3 and 2 of COM(2005)628 final

Relevant research questions in connection with these really existing CO2-emissions from wood burning are: How do the emissions go up into hemispherical circulation patterns? The answer should specify both time and space components. To demonstrate the insanity of any view of automatic CO2-neutrality from tree-burning, it should also be demonstrated, how CO2 emissions add to hemispheric winter peaks in CO2-accumulation, because wood is burned for heating purposes at a time, when local CO2-uptake for photosynthesis is minimal. This would make it clear, why there is a global problem of over-accumulation of CO2 from wood burning. Seen as part of hemispherical air circulation patterns, it can also be made clear, that the CO2-absorptive power of woodlands is in no direct local relation to wood burning installations which on the contrary pollute the global commons. This means, that there is no idyllic privilege of reserving these commons for local emissions from wood burning, as some illusory feelings of living in harmony with nature might tell.

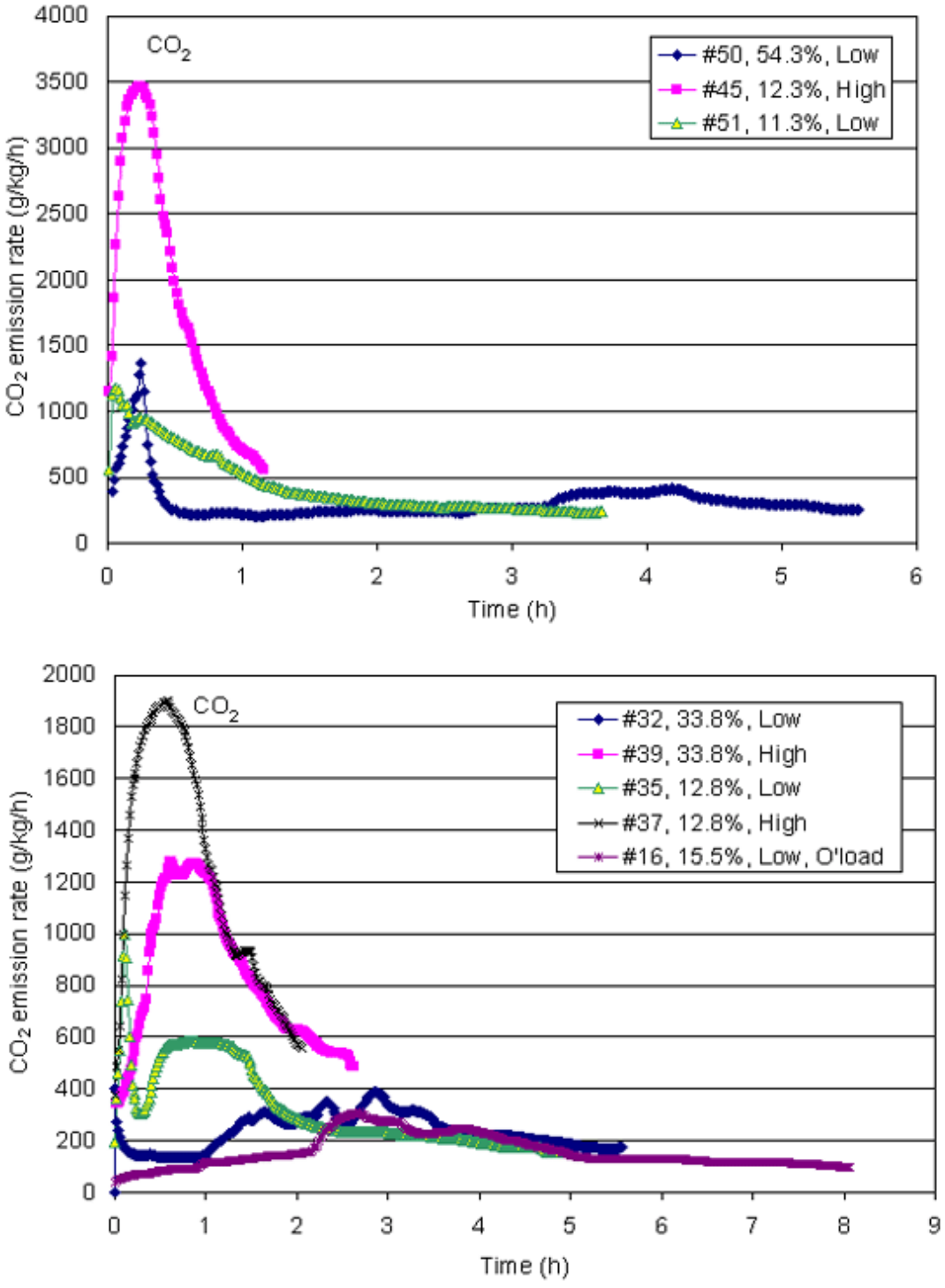

Fig. 4b. ***Varying CO2-Emission rates over hours of burning for two types of tree (Redgum above, Pine below; # refers to samples).***

Source: Environment Australia 2002

Instead, research on the complexities of CO2-binding in forests with different management strategies is of paramount importance. As is reported after 10 years of scrutiny in an area with continuous cover forestry in Zealand: "The high C stock in

semi-natural forests also suggests that more C could be stored by conversion from the traditional forest management system based on clear-cutting and replanting to continuous cover forestry with focus on the maintenance of the dead wood component."[55] The author has supplemented this conclusion in Danish broadcasting with an estimate, that 2-3 times as much CO2 could be stored in a semi-natural forest. So, if CO2-binding is the issue, there is an alternative option with bigger perspectives than giving people license to a free lunch with wood burning that has no place in ecology. The state forests in Denmark have at least a policy in the direction of semi-natural forest management.

5. Wood firing: Substitution and End-of-Pipe-Regulation

5.1 Breaking the curve of extended wood burning

On the Danish territory, only around 11% of the land area consist of forests, and a plan from 1994 to double this proportion within a tree generation, i.e. 80-100 years, has as yet not been sufficiently implemented. Nevertheless, a biomass law of 2003 proposes the political aim of augmenting the use of both straw and wood for energy purposes. Therefore, the cited prognosis of NERI to double the amount of wood used for energy purposes from 2005 to 2030 is a 'realistic' proposition, politically seen – as long as political aims are formulated by consensus, which are inconsistent with natural laws.

It can namely not be called realistic in the physical sense of the term to reckon measures as CO2 emission reductions, which actually increase those emissions in a measurable way – only because this is declared as being part of a conventionally adopted strategy for sustainable development. This is only possible as long as the illusion of an a-priori-CO2-neutrality of all biomass burning is maintained. Underlying this illusion at the local level is an image of natural unity between the private house burning its wood reserve and the forests in its nearness. As told above, this image is at odds with the physical, i.e. time-spatial, realities of CO2-emissions from room heating and their hemispherical circulation.

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[55] Lars Vesterdal and Morten Christensen 2007: The Carbon pools in a Danish semi-natural forest. ECOL.BULL. 52 (ed. by Katrine Hahn and Jens Emborg, Suserup Skov: Structures and processes in a temperate, deciduous forest reserve), 113-121

A physically and socially realistic reduction policy regarding wood burning is, however, in Denmark confronted with a massive problem, because private wood burning has been doubled from 1990 to 2005, especially since year 2000. Around 2005, circa 500 000 wood stoves were in use in Denmark, half of this in urban areas with more than 50 000 inhabitants. A goal of halving the number of wood stoves in use is, thus, morally a priority and a realistic proposition, because collective supply networks usually are nearby.

But this cannot be done from one day to the other. A responsible energy, environment and climate policy that in the sense of the precautionary principle could function as a prophylactic health assurance, has, therefore, to develop a double edged strategy. Measures for the short to medium sight, inclusive end-of-pipe-regulations, have to be demanded and implemented in such a way that they don't foreclose access to and an eventually accelerated implementation of more fundamental changes according to principles of substitution.

Besides working out economic schemes and administrative rules for applying the end-of-pipe-solution for particles e.g. by the high-tech-filter system which, as mentioned in ch.1, gives a clear positive social surplus,[56] it should be an essential priority to substitute more rational energy supply and application systems for continued individual wood burning as well as heat losses from private dwellings. Improvements of housing construction methods, as they now are under way also in Denmark, make possible to ‚break' a rising curve of wood stove use in 2020 at the latest – according to scenarios that build upon a rising trend up till then.[57] This breaking the curve is what has to be done - and indeed much earlier than 2020, because the CO2-reduction commitments for that time cannot really be attained without disclosing emissions from private wood burning, too.

On the supply side, distribution systems for wind electricity could supply electric heat pumps and/or local distribution systems for biogas could supply gas-driven heat pumps – either in private dwellings or as part of local co-generator systems. According to a 2007 life-cycle analysis of the Darmstadt Öko-Institut reported to the German Ministry of Environment biogas-driven co-generators are by far the most

[56] according to NERI Environmental Project 1164/2007

[57] As is the case with the LF-scenario of Klaus Illums Eco-Consult report 2008. Communication from Klaus Illum.

CO2-binding energy converters to (heat and) electricity.[58] They could be connected to natural gas distribution networks as a kind of back-up. In this way, natural gas could, indeed, function as a transition fuel – a point which is critically evaluated by Hermann Scheer of Eurosolar.[59] German suppliers are today investing in combined feed-in-systems for natural gas and biogas – whereas similar projects were cancelled in the United States as part of the general decimation of the U.S. federal energy policy, when President Reagan took over.[60]

In the short run, it is even recommendable to maintain individual natural gas heating installations because of their energetically and environmentally more benign effects - and not to substitute individual wood burning for them. [61] To evaluate this alternative, the issue is partly to compare with efficiencies in collective systems – an argument which applies to both kinds of individual supplies. The issue is partly one of security of supply, which seems to favour wood burning. But: (a) an enlarged weight on wood burning has in this respect to be based on more reliable evaluations of sustainable yields of wood from Danish forests alone (without imports)- also recognising effects of global warming on stands of wood as well as release of CO2 from the ground; (b) the said application of biogas for co-generator systems that also deliver room heating should be more thoroughly evaluated on the basis of an enhanced policy for extended biogas generation – thus improving the supply security of a fuel that can be mixed with natural gas in varying proportions (after cleansing).

5.2 The case for a substitution policy

The option to change technology by substitution, which recently has been included by the European Parliament into EU's chemicals legislation (REACH), has earlier been shown to be more effective environmentally as well as economically than end-of-pipe additions (Commoner 1992). As Commoner showed by detailed statistical analyses covering the first ten years of US-American environmental policy, the intended reductions of environmental pollution by a factor of 10 were only realised

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[58] Fritsche, Uwe R. 2007: Treibhausgasemissionen und Vermeidungskosten der nuklearen, fossilen und erneuerbaren Strombereitstellung - Arbeitspapier – Öko-Institut Darmstadt, chap. 4.

[59] Hermann Scheer 2005: Energieautonomie, München, part I.

[60] Der Spiegel, no. 38 and 39/2007; Rolf C.-Dupont 1982

[61] Shifting from natural gas heaters to wood stoves implies an increase (!) of CO2-emissions of at least around 80% seen from the CO2-emission factors per unit of energy released, see table 2 above.

in the few cases, when polluting substances were completely substituted by less harmful ones.

End-of-pipe-regulations did in contrast not reduce environmental stresses essentially and were in danger to be compensated by increased use of the same, only somewhat less polluting technologies. This rebound effect can only be avoided by successful substitutions. End-of-pipe regulations imply bigger and enduring costs of maintenance, thus contributing to the perceived conflict between ecology and economy, whereas substitution efforts demand one-time and in the short run perhaps bigger investments in technologies, which are better adapted to the ecological space of manoeuvre and, therefore, make surpluses in the long run. They can e.g. systematically promote a shift of the exploitation of resources from non-renewable to renewable ones.

Substitution solutions are, thus, often more effective both economically and environmentally, but their implementation calls for a coordinated effort by multi-level governance, where multi criteria evaluations should be produced collectively. Democratic discussions between enlightened citizens, which are necessary before taking the more transforming steps of substitution policy, can be furthered by an opening of the concept of scientific inquiry corresponding to the strategy of post-normal science (Rolf C.-Dupont 2007). Here, two extensions of Kuhn's normal science are practiced: (a) the conscious inclusion of 'extended facts' in scientific discourse, meaning an opening of disciplinary closures regarding what constitutes facts of relevance, e.g. by stressing the character of a trans-disciplinary problem to be solved; (b) the conscious inclusion of ‚extended peers' in scientific enquiry, who may be citizens who actually have to live with a given problem and share at least local knowledge about it and try to preclude it in the future. This approach makes an intensified dialogue possible, which apparently is needed, if a new policy regarding the toxic freight from wood burning and effective ways to reduce it shall be implemented locally and imply shifts of lifestyle.[62]

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[62] The new Danish departmental order on wood stoves coming into force in 2008 is not only intended to modernize wood burning appliances (it has been admitted only to reduce the overwhelming particle freight by 25% until year 2020), but opens up for municipalities to delineate areas where they can concentrate more direct regulatory efforts. There is, however, no provision made as yet for supplying the municipal technical administrations or local citizens with additional resources to fill this gap e.g. for further education and for investments in measuring devices for particles, costing from Euro 6000.- upwards.

6. Global deficits of dioxin regulation

As a response to the 1986 International Dioxin Congress in Fukuoka/Japan environmental chemist Theodore Goldfarb commented upon the reception of the poster exhibition of Vietnamese scientists, which depicted the enduring tragic health damages of their population because of the spraying of Agent Orange by U.S. and south Vietnamese military forces many years ago, by mainstream scientists:

„It simply appeared that there was an unwillingness to accept the possibility that the first clear evidence of devastating human health effects caused by dioxins may come from this poor Southeast Asian country that was the victim of chemical warfare waged with one of the inappropriate products of western technology.- Inappropriate evaluation of data is common, but the degree to which these experts were unwilling to look at the facts is shocking – and irresponsible." (Goldfarb1986).

Extended regard of facts, as it is recommended in the said discussion on post-normal science, can only be accomplished and become the basis of new data, if that kind of Macho elimination of contradictory evidence is overcome – and no longer promoted as scientific 'discipline'.

6.1 Contested dioxin risk assessment methods

That the second step of evaluating data (after having selected them) leads to many a controversy, was an experience, I had made in the related context of discussions about health effects from chronic low dose exposition to ionizing radiation[63]. The whole nuclear debate was a scaring experience of, how difficult it was to produce consensus in scientific and policy circles on risk evaluations. On this background, I saw an intellectual challenge in the mid-1980s in trying to trace similar disagreements in relation to risk assessments of chlorinated dioxins and furans, especially regarding chronic low-dose exposure.

I knew from the minutes of the international 1983 symposium on the dioxin contamination of the Georgswerder land-fill in Hamburg, that Chicago oncologist Samuel Epstein was of the opinion that only a molecule of Dioxin theoretically can provoke cancer growth. When I publicly criticised the more conventional wisdom of cancer risk assessments for dioxin (see below), I met fierce resistance from Danish authorities because of what they meant was a real schism between two different

[63] The Danish Organisation for Information on Nuclear Power (OOA) had in the late 1970s organized an international conference at Copenhagen on this issue.

ways of making this assessment. At the international Dioxin'85 Congress held at Bayreuth, I experienced, how this schism divided the U.S. EPA from the researchers of Dow Chemical: Mr. Kociba of Dow Chemical interrupted here the presentation of U.S. EPA's senior researcher Debdas Mukerjee, who was just going into details of, what further symptoms of health damages EPA had found, when re-evaluating the test data which Dow Chemical had reported to them from a two-year toxicity test of dioxins applied to rats. Mr. Kociba volunteered with a remark that it was him, who had made the experiment. Therefore, he knew better.

The controversy between US Chemical Corporations and U.S.EPA regarding research of relevance for dioxin risk assessments was, at that time, becoming a permanent issue. The interpretation of Mr. Kocibas test results had become the cornerstone of risk assessments followed by WHO and by European governments. Methodologically they were carried through as if dioxin could be subsumed under regulations for food additives. They rest upon an assumption of a No-Effect-Level or a No-Observed-Effect-Level, below which PCDD/F allegedly do not any (observable) harm. The numerical result is given in the form of positive tolerable doses of intake of this toxic substance over a time period (day or week).

A working group at the Center for the Biology of Natural Systems (CBNS) in New York led by Barry Commoner applied, in contrast, another critical, cancer statistical way of dioxin risk assessment, when they in 1983/84 tried to estimate risks of exposure to air emissions from eight big-size Municipal Solid Waste Incinerators that were being planned for the boroughs of New York City and would carry particles into the dwellings of several million inhabitants (Commoner et al. 1984). Analytically based estimates of the expected frequency of additional cases of cancer in the exposed population were here compared to the normative limit of acceptance, that no more than 1 additional case of cancer in a 70 years lifetime should be accepted within a population of 1 million.

This critical-analytical mode of regulation made, thus, one of the toxic effects of dioxin, the – direct and/or indirect - cancer causation, to the common yard stick for research and for political evaluation. As the use of the CBNS research for critical citizen groups shows, made this clear division between methodologically transparent fact finding and normative evaluation possible to empower citizens to function in those extended peer-groups who are introduced into decision making e.g. in post-normal science as distinct from normal scientific definitions of peer groups within disciplines (Sources given in RCD 2007). This is indicated, when issues at stake are so high and at the same time uncertainties so extreme, that neither normal science nor consultancy can do the job. As a matter of content, the action research of CBNS included many ‚extended facts' (as e.g. the intoxication in dwellings by particles) which the established authorities or engineering firms had not included.

On these premises, I tried to promulgate knowledge of this mode of risk assessment as an alternative to the acceptable-intake method, which in Denmark was seen as a non-plus-ultra. Also in the U.S. itself, the Reagan administration tried to eliminate the critical method and introduce the intake-method instead. So, I was lucky to hit

centre-point of this science-political conflict, when I proposed to make a comparison between these two methods as a contribution to Dioxin ´86 in Fukuoka/Japan. The speech was also published in the proceedings volume of CHEMOSPHERE 1987 (R.C.-Dupont 1987).

6.2 Independent research on health effects of dioxin

Also in 1987, U.S. EPA established a ‚task force' that should make a revision of the EPA method to adjust it to the bureaucratic mainstream defined by WHO and other governments (Commoner 1990, S.75). As Commoner reports in „Making peace with the planet", the centre of disagreement was the contradiction, whether to regard the impact of dioxin on cancer development as complete, direct causation or only as indirect promotion. According to Commoners knowledge, both positions were inadequate, because the Seveso-dioxin TCDD unfolds a strong catalytic effect by way of the activation of enzyme systems, which by way of synergy transform latent carcinogens present in the body into actual ones and thus augment their cancer growth effect.

Commoner argues explicitly for his expectation, why the sensitivity to a chemical carcinogen on the level of individuals of human populations because of their known heterogeneity will „include individuals with sensitivities that differ over the whole range of variation – that is, in the case of AAF (a carcinogen called aminoacetyl fluorene, rcd) the range from guinea pigs (which are not affected because of lack of a gene responsible for activating the necessary liver enzyme, rcd) to rats" (70).

The concept of differing human chemicals sensitivity has in recent years been explored more widely, one of the pioneers in this field being the physician Karl-Rainer Fabig (1945-2005), who in December 2004 presented his views on "Multiple chemical sensitivity seen from physiological and genetic properties of human populations affected by chemical stress" at the Roskilde workshop of the network www.sustainability-strategy.net. [64]

Karl-Rainer Fabig worked as general practitioner in Hamburg. On occasion of a Vietnam visit in the late 1970s he took – contrary to the professionals accused of wishful ignorance by Theodore Goldfarb above – notice of the cruel health damages caused by the U.S. American and South Vietnamese air spraying on ca. 17 000 km^2 with more than 360 kg TCDD contained mainly in the product Agent Orange (for

[64] See the minutes from the workshop and Fabig's contribution either at the link given above or at www.geo.ruc.dk/nors/tnwsus.htm.

comparison: on occasion of the Seveso incident, probably 5 kg TCDD had been released at once on a much smaller land area). Similar health damages were found by Fabig in some of his patients who had worked at the chemical factory of Boehringer/Ingelheim in Hamburg that was closed down in 1984 because of widespread dioxin contamination.

Fabig contributed in two consecutive steps to the international dioxin research. The first consisted of his ample documentation by diagnostic picture producing brain scanning methods of health damages with personnel of e.g. a day-care institution North of Hamburg, who had been exposed to measured dioxin indoor concentrations that had evaporated from PCB-containing wood preservatives. Fabig documented statistically by contrast to control-groups that the dioxin contamination caused elevated risks of reduced blood flow in the frontal zone of the brain being functionally necessary for the full performance of perceptive tasks. This finding, which he presented by posters and orally at the 1988 Umeå dioxin congress, was never documented in the proceedings, however (RCD 2007).

As the complete silence after his presentation in a discussion plenum at Dioxin 1988 in Umeå manifested, the ‚big research' experts and official administrators convened saw the danger of being forced to make more fundamental revisions of dioxin risk assessments in the opposite direction of what the political pressure demanded. Fabig asked, whether dioxin effects by inhalation on the central nervous system should not be included in the risk assessment methodology. His own interpretation was that an inclusion of the risk of TCDD moving into the brain would have falsified the assumption of a lower threshold, where there is no harmful effect of dioxin 'intake' (measured mostly in blood fat). The only modification, which had been proposed by Nordic experts was to make a symbolic change in defining an interval against zero as new limit value (Ahlborg et al.1988) – but not even this step of modification has been taken, presumably because the whole edifice of the WHO risk assessment method rests on too shaky grounds.

In response to the failure of a lengthy juridical procedure at Frankfurt am Main in the 1990s against firms that had produced PCB-containing wood preservatives, where Fabig had been consultant for the prosecuting citizen groups of victims, he was in the new millennium interested to find out, why and how the health risks from dioxin and other chemicals are unevenly distributed among individuals of our population resulting in a mere probability of harm, which the juridical system as yet has not accepted as a crime. The line of reasoning found in Commoner 1990 on this issue (see above) was empirically demonstrated in a cooperation with specialists in diagnostic genetics and enlarged to comprise the whole question of a more ubiquitous health problem for patients classified under the rubric of 'multiple chemical sensitivity'. The lasting importance of these findings, some of them issued posthumously (Schnakenberg, Fabig et al. 2007), lies in the grounding of subjective experiences of heavy impairment of quality of life by the so-called normal circumstances of our chemically polluted world in objective conditions of genetic set-up.

This makes it completely unacceptable, when representatives of the Danish environmental authorities repeatedly have ushered the notion that one cannot and need not react when only a single affected neighbour – who knows? – reports problems about smoke pollution. This contrasts in an ugly way with the somewhat dramatic, but in fact realistic admonition by environmental authorities in Washington State, that nobody has the right to ‚smoke out' one's neighbour (Washington State update 2004).

And it violates one of the fundamental principles for a transition to sustainable development in the world-system, namely the precautionary principle meant to protect vulnerable human as well as non-human populations: "When lack of precise knowledge only is to be compensated by time-consuming testing and research activities, these should, however, not be used as an excuse to postpone precautionary action, granted that there is a reasonable suspicion of serious adverse effects. These will often, moreover, be unevenly distributed within the population concerned. Then, the necessary protection of especially vulnerable minorities – as children or elderly people – must guide remedial action." (RCD 2006)

6.3 A legacy demanding historical change

Apparently, the traces of the historical failures of the U.S. warfare in Vietnam still cause essential deficits in environmental policies regarding hyper-toxic chemicals that have persisted since the mid-1970s, when the U.S. forces were withdrawn from Vietnam. This has impeded necessary societal learning processes and divided their results into half truths.

Although the U.N. system in this millennium has taken the right normative approach to out-phasing POPs, the application regarding dioxin is still half-hearted, as the Danish example shows. This dates back to old controversies in the U.S.A. itself. Their dioxin policy is characterized by a chaotic process of power politics applied to truth finding ever since U.S.EPA in 1987 was directly hindered by chemical corporations to implement its dioxin policy, formulated two years before. Since the beginning of the 1990's corporate interests have been decisive for the making and remaking of 5 different dioxin reassessments (Centre for Health and Environmental Justice www.chej.org.). The fifth reassessment was furthermore evaluated by the U.S. National Research Council (2006).

Many U.S. veterans from Vietnam themselves have been severely affected by the spraying actions with Agent Orange. Nevertheless, there is no mercy with the catastrophically affected Vietnamese, as yet. The grass root organisation fighting for the rights of compensation for some of the worst victims (who still suffer from giving birth to severely affected children) was in the latest years twice rejected at courts in the U.S. denying them any right to prosecute the chemical firms who produced the more than deadly mixtures. This was, otherwise, a possibility that could have resulted from a beginning official cooperation to document the mid- and long term impacts of the spraying actions on environment and health; which unfortunately was nullified by political decision (Fabig 2005/2007).

Only after a spectacular catastrophe in one of the European core countries, Italy, when the chemical factory Icmesa at Seveso exploded in 1976 and released ca. 5 kg dioxin, the theme was on the political agenda in Western nations. In the 1980's the accident gave name to the EU-directive on hazardous industrial facilities, but the Seveso case itself was subject to the same cover-up strategies - not the least because of an assistance agreement between the Italian authorities and U.S. administrators - as the whole issue in general.

6.4 The unsolved problem of dioxin from atmospheric burning of organic matter

A sector specific dioxin problem, the formation of dioxin in municipal solid waste incinerators, became, however in the 1980's a special challenge for environmental authorities, who had pushed the incinerator industry as a means of last resort in their waste management efforts. Grass roots initiatives were putting the issue on the table of often unprepared environmental authorities, who could not 'solve' the problem without modernising both the sector and their own administration of new research results.

EU legislation played, here, an important role, as said above, by setting a limit value to the dioxin content in air emissions at nano-level (0,1 ng[65] per cubic-meter exhaust air, measured in international toxicity-equivalents (I-TEQ) of Seveso-Dioxin [TCDD]). This limit value could only be achieved by adding exhaust air scrubbers and active coal filters - and only with the result of producing a pollution problem in solid waste. The dioxin containing filter mass has, namely, to be deposited without contact to the biosphere, which e.g. meant burying them in German salt caverns – not just a sustainable solution, as German authorities have told Danish firms in fall 2007.The shifting of dioxin pollution from air to salt caverns has only temporally helped to lessen the impact on living creatures either directly by air used to breath or indirectly by the deposition on sea and land areas, where food is harvested.

Now, in an era of rising oil prices and a very indirect climate and energy policy, which does not really dare to reduce the quantities of oil lifted to the surface of the

[65] 1 nano-gram = 10^{-9} g

Earth,[66] the air contamination by traditional wood burning is a new issue because of scientific-technical progress in measuring emissions of not only dioxin, but also PAH and ultra-fine particles. The result is catastrophic for adherents of this inherently dioxin producing technology, because the dioxin emissions and the 'normal' emissions cannot be handled in the same way, see above. But the political will to make radical changes by substitution is virtually non-existing, as long as CO2-neutrality of the burning of biomass (in short rotation) can be used as an excuse.

Before better insight will win, this paralysis produces the impression, as if local, health oriented criteria for technology assessment in this question are incompatible with global, climate related criteria. The study presented above argues in the contrary for an application of the precautionary principle to technology assessment, which should apply the threefold criteria of compatibility with both local and global environmental demands – and an economically as well as ecologically sound development in developing countries proposed by Commoner 1990 (p.198). Only by this way, a contribution to the restructuring of societal metabolism on world scale is made possible that is in tune with the goal of a sustainable world-system development which we might construct.

7. Conclusion

We have in this text assembled evidence to judge the compatibility or lack of it of stem wood burning, especially in individual wood ovens in densely built-up areas, with sustainable development from a comprehensive, social scientific perspective. As stated in the introduction, an approach to three dimensions of sustainability was used as the overall point of departure, which was proposed by the reporting team of a UNESCO project on 'Sustainability and the Social sciences' (Becker and Jahn 1999). They talk about the necessary articulation of this concept in a normative, an analytical and a political dimension.

In the text above, I have proposed discussion materials on the *normative* dimension in chapter 1 on the U.N. led Stockholm Convention; on the *analytical* dimension in chapters 2-4; and on the *political* dimension in chapters 5+6. Applying the

[66] As proposed by Iranian economist Mohssen Massarrat in his critique of the dilemma of an ecological tax reform of either reaching only too low taxes, thus being ecologically without effect; or aiming at high taxes that are politically not manageable, see my book review in DAS ARGUMENT, vol. 41/1999 (nr.233)

corresponding definitions of sustainable development from the 1987 Report of the World Commission on Environment and Development on each of the dimensions, the following conclusions are reached:

(a) in relation to the visionary definition re. *intergenerational justice* in terms of potentials for sustenance, the effort of the Stockholm Convention on POPs is, indeed, needed, but its norms are in our case more verbally followed and in case of doubt severely violated by administrations as the Danish environmental authorities who construe a conflict between local and global pollution regulation, which is badly based on false analytics that can't live up to the historical challenge;

(b) in relation to the analytic definition re. *sustainable resource use* which could be accomplished by balancing processes of institutional change, of technological development and of the direction of investments with the exploitation of resources it must be concluded that

(i) progressive ***institutional change*** in energy and environmental policies has been halted and/or reversed by waves of deregulation and tax-exemption spreading low chimneys without any cleansing for contaminated wood smoke over the landscapes in both country and town;

(ii) technological development has been treated as black box in private hands, meaning that no authorities have been able and/or willing to halt and revert the market-derived rush into wood burning and by selective industrial policy to support either filter-development or substitutions for this ill-conceived El-Dorado-heating systems[67];

(iii) the ***direction of investments*** in this kind of heating equipment has not been coordinated with historical or actual investments in collective cogeneration systems, clean renewable sources of energy or investments in further reductions of 'heat loss' in buildings;

(iv) the ***exploitation of resources*** has not been reduced sufficiently and openly coordinated with changes in the other dimensions, but has been wrenched into a dogmatic adherence to the virtues of wood-firing in private hands, as if the famous invisible hand of no-regulation would rescue the world from the ensuing imbalances, not the least in the atmospheric carbon content.

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[67] The Danish authorities have reserved money for testing the filter equipment of the Norwegian firm APP; but their regulation of the wood stoves sector includes no assessment and/or recommendation of alternative approaches.

To sum up:

1) Net growth of plants in the ecosystems of a better world could perhaps compensate as quickly as needed to net additions of CO2 emitted from the burning of stem wood. But in the world of today with market price differentials as a mighty driving force for *resource exploitation* that is not regulated sufficiently, this is no realistic proposition. In this sense the CO2-binding capacity of ecosystems is devalued and cannot be used to distribute CO2-credits to wood resource exploiters;

2) *investments* in both active energy supply and passive energy use structures that further alternatives to stem wood burning should be furthered by all means possible;

3) *technologies* in accordance with this goal should be maintained and further improved; and

4) *institutions* which help to accomplish the implementation of a selective industrial and consumer policy that promotes these changes have to be strengthened and/or constructed – in case of doubt also against market forces (both real and ideological) that make an internalisation of external costs more difficult.

In this manner, the tradition of *writing alternative energy scenarios* should be extended by a more direct consideration of the institutional dimension of sustainable development.[68] It could, thus, further the goals of a comprehensive world-system development in the direction of sustainability by proposing a new, post-carbon metabolism of society.[69]

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[68] Thus correcting for the one deficiency of traditional alternative energy scenarios, which was conditioned by state fixation (R.C.-Dupont 2003)

[69] There is in the sense of post-normal science still a need for critical research on the topic of a post-carbon society (European Commission 2008) that can contribute to new results also outside of the EU 7th Framework Programme of Research, which we (without success immediately) tried to apply for in a project description on 'Double decoupling for decarbonisation and democracy (4D).'

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